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RESEARCH DEPARTMENT

Visit to I.R.T., Hamburg

REPORT No. A-077

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THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

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A handwritten signature in black ink, appearing to read 'D.E.L. Shorter', with a stylized, cursive script.

D.E.L. Shorter, B.Sc.(Eng.), A.M.I.E.E.

(D.E.L. Shorter)

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Section	Title	Page
1.	INTRODUCTION	1
2.	LOUDSPEAKERS	1
	2.1. General	1
	2.2. Loudspeaker type 0-85	1
	2.3. Production of Loudspeakers	2
	2.4. Loudspeaker Amplifiers	3
3.	STEREOPHONY	4
	3.1. Studios and Cubicle Equipment	4
	3.2. Programme Distribution	5
4.	CONTROL OF MODULATION LEVEL	5
	4.1. General	5
	4.2. Control Instructions	5
	4.3. Use of Limiters	6
	4.4. Propaganda Transmissions	7
	4.5. Attempts at Loudness Indication	7
5.	MISCELLANEOUS	7
6.	REFERENCES	8

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1. INTRODUCTION

During a visit to Hamburg occasioned by the meeting of the E.B.U. Working Party S on 10th to 13th December 1962, the opportunity was taken to spend a day at the Institut für Rundfunktechnik (I.R.T.), gathering information on current practice in some aspects of audio-frequency engineering of immediate interest to the Corporation. Discussions were held with Dr. Schiesser, who is responsible for the audio-frequency side of the I.R.T. work on stereophony, together with Mr. Belger and Dr. Kuhl, who were consulted on matters concerning programme metering and loudspeakers respectively.

The regional structure of the West German broadcasting system allows some variation in engineering practice between the various organizations, and for this reason it was not always possible for the I.R.T. staff to give an unambiguous answer to every question put to them. In the absence of a statement to the contrary, therefore, the information set forth in the succeeding sections should not be assumed to apply universally throughout the Federal Republic.

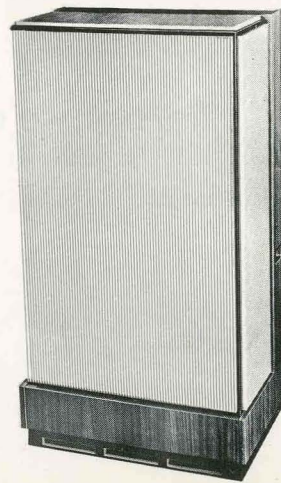
2. LOUDSPEAKERS

2.1. General

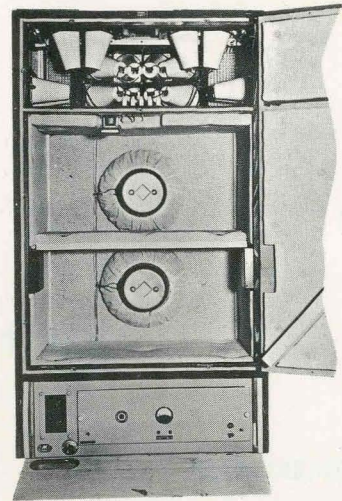
Of the loudspeakers in use in the West German broadcasting organization, many are of the well-known 'omnidirectional' type, having a number of high-frequency units disposed over the surface of a sphere,¹ now modified, as a result of experience, to introduce a certain degree of directivity.² A three-unit assembly, produced by the German firm of Klein and Hummel, using Electrovoice components, has also been employed, but its performance is inferior to that of the loudspeakers designed by I.R.T. and, more important still, the production variation in performance is considered excessive. The same remarks apply, but with even greater force, to the three-unit assembly employing Goodmans components (recently tested by Research Department) which was tried experimentally in the studios at Baden-Baden but is not in general use.

2.2. Loudspeaker type 0-85

The latest monitoring loudspeaker, developed by I.R.T. about three years ago^{2,3} and now in increasing use throughout the A.R.D., is the type 0-85, illustrated in Fig. 1(a) and (b). This loudspeaker is rather bulky by British standards, the dimensions being 0.795 m (2 ft 7 in) × 0.48 m (1 ft 7 in) × 1.45 m (4 ft 9 in) high, but a slightly smaller model, the 0-85a, of dimensions 0.64 m (2 ft 1 in) × 0.37 m



(a) External view, front



(b) Rear view, back open

Fig. 1 - I.R.T. monitoring loudspeaker type 0-85

(1 ft 3 in) $\times$ 1.32 m (4 ft 4 in) high, claimed to give equivalent performance, has now been designed. As in the earlier monitoring loudspeakers, a number of additional high-frequency units is provided for the purpose of increasing the amount of reverberant sound in the room; in justification for the use of such an arrangement for broadcast monitoring, it was stated that a great number of German radio receivers are fitted with supplementary loudspeaker units - mounted, for example, in the sides of the cabinet - in order to produce a more spacious effect.⁴ The 0-85 design, however, represents a partial retreat from the original concept of omnidirectional radiation as an ideal. It differs from its predecessor in that the units employed to increase the reverberant sound are directed sideways and upwards only, and radiate at a lower level than the rest, while the low-frequency units are arranged, by a combination of appropriate cabinet design and electrical equalization, to give a roughly cardioid polar characteristic. There is still some divergence of view among the different broadcasting organizations within the A.R.D. as to the degree of directivity desirable in a monitoring loudspeaker and in the 0-85 design the I.R.T. has been reluctantly obliged to make provision for increasing the 'presence' of the reproduction by switching off the sideways- and upward-pointing units, at the same time introducing electrical equalization to keep the mean spherical frequency characteristic the same; this facility is in any case necessary when the loudspeaker is used for stereophony, in which pseudostereophonic effects⁴ are not desired.

A demonstration of an 0-85 loudspeaker was heard in the I.R.T. laboratory. With the 'presence' control set for maximum directivity, i.e. with the upward- and sideways-facing units inoperative, the quality was judged to be comparable with that of other high-grade loudspeakers of more conventional construction. With the control set for maximum reverberation, i.e. with the supplementary units operating, the reproduction not only sounded more distant, as if the microphone had been moved back in the studio, but appeared to come from some point to the rear of the loudspeaker cabinet.

2.3. Production of Loudspeakers

In view of the difficulties recently experienced by the Corporation in the supply of monitoring loudspeakers, it is of interest to consider some details in the production of the type 0-85 assembly.

I.R.T. lays great stress on the importance of avoiding audible differences in performance between individual monitoring loudspeakers. Frequency characteristics, measured in production with third-octave bands of noise, are subject to a tolerance of ± 2 dB over the entire frequency range, plus an additional allowance of 1 dB in any *one* band. The use of a number of nominally identical high-frequency units is conducive to constancy of overall performance in manufacture, since some production variations are likely to be averaged out; at the same time, the relatively high power-handling capacity of a multi-unit high-frequency system allows the crossover frequency to be placed as low as 550 c/s, so that the low-frequency units have only to cover a very restricted range.

The high- and low-frequency units employed are manufactured by the firm of Isophon; both have to be selected. The low-frequency unit is a standard model; the high-frequency unit is a standard model modified by the addition of a copper ring mounted on the centre pole of the magnet system and of a concave stiffening element attached to the diaphragm.

The assembly of the complete loudspeaker is carried out by the firm of Telefunken, which is also responsible for the selection of units. The high-frequency units received from Isophon are further modified by Telefunken by covering the openings at the rear of the chassis with a layer of fabric, of prescribed flow resistance, and are then fitted with plastic rear covers (see Fig. 1(b)) partly filled with sound absorbent material. The two low-frequency units are also provided with external damping material, in this case held in position at the rear by a scrim bag. The directional properties of the loudspeaker at low frequencies are produced by apertures on either side of the cabinet; these have to be packed with absorbent material of appropriate density.

It will be seen from the foregoing that the manufacture of a loudspeaker of this type is far from straightforward and requires facilities for acoustic measurements. These factors are naturally reflected in the cost of the finished product; the price of the type 0-85 loudspeaker without amplifier was quoted by I.R.T. as DM 1800 and by Telefunken's English agent as £285. About two-thirds of the type 0-85 loudspeakers produced by Telefunken to date have been sold to the West German broadcasting organizations and most of the remainder to recording or film studios.

2.4. Loudspeaker Amplifiers

The amplifier which drives the 0-85 loudspeaker was originally rated at 25 watts output but the design has now been modified to give 35 watts in Class AB operation without increase in cost. The amplifier is manufactured by Telefunken and sold to the German broadcasting organizations at DM 970; the English price is given as £155. I.R.T. is concerned about the high cost of this amplifier and has investigated a number of commercial products of lower price; all of these, however, have been open to objection, either on grounds of performance, or because of the necessity for modification or on account of objectionable design features such as excessive reliance on electrolytic capacitors.

For some applications, programme is distributed to loudspeakers from a central 100 watt amplifier. This amplifier employs an ingenious overload protection circuit. Excessive output levels are accompanied by a rise in the feed to the output stage, causing a lamp connected in the screen supply circuit to glow; this lamp illuminates, and thus renders conductive, a photocell shunting the signal circuit in an earlier stage, thereby producing protective attenuation.

3. STEREOPHONY

3.1. Studios and Cubicle Equipment

As there are at the moment no stereophonic transmissions which could be received by the public, there is no outlet for any stereophonic programme material which may be produced in the studios. This situation is not likely to change in the immediate future, for the series of experimental transmissions on the Zenith-G.E. system now being planned will rely exclusively on commercial recordings. Preparation is, however, being made for the production of stereophonic programmes at a later stage.

I.R.T. does not consider it necessary to modify the design of studios for stereophony. Lack of manoeuvring space in drama studios, which was a cause of complaint in BBC studio experiments, has not been experienced in the Federal Republic, where drama studios vary in volume from 300 m³ to 600 m³ (10 000 ft³ to 20 000 ft³). Special provision for stereophony is therefore confined to the associated cubicles and equipment.

At present, one studio in Berlin and one in Freiburg has provision for stereophonic working. In Hamburg it was originally intended to adapt three studios for stereophony but the first estimate of the cost was so high that it has been decided to equip only one for the time being. By the end of next year about 10 studios, including most of the larger studios in the new premises under construction in Munich, will have stereophonic equipment.

In the Munich studios, additional rooms are provided for stereophonic listening or for use as supplementary cubicles to permit separate control of the monophonic and stereophonic programmes.⁵ These rooms have no window into the studio; in discussing the possibility of using closed circuit television in such a case to enable the movements of performers to be observed, it was noted that Bayrischer Rundfunk already employs this device in large-scale productions. The volume of the cubicles is about 90 m³ (3000 ft³), i.e. about the same as that of the A.F. Section listening room at Kingswood Warren; it should be noted, however, that this figure had already been decided on before the requirements for stereophony arose.

In existing cubicles converted for stereophony a single control desk, capable of stereophonic or monophonic operation, is provided. The stereophonic control desks used in studios are supplied by Telefunken, but portable desks for outside work have been obtained from Neumann and others. Details were given of a standard Telefunken stereophonic studio desk which has three stereophonic channels and six monophonic channels with panning controls; the monophonic channels can be used in twos to make three additional stereophonic channels; to this end, the faders, which are of the carbon track type already in use in monophonic control equipment, are selected in matched pairs and mechanically linked as required.

In laying out a cubicle for stereophony, the loudspeakers, of the type 0-85 referred to in the previous section, are placed about 3 m (10 ft) apart on either side of the window into the studio; the sideways- and upward-pointing units are switched off, and in this condition the loudspeaker is considered to be sufficiently directional to avoid producing unwanted effects due to reflection from the glass. The control desk is set back some 3 m (10 ft) from the studio window, at the cost of some reduc-

tion in the field of view. The arrangement is subject to the usual restrictions on the placing of the observers in the cubicle; the somewhat elaborate arrangement, involving two additional loudspeakers in the centre of the stage, devised by Dr. Kuhl⁶ to widen the usable listening area, is not now used (except, it is believed, in East Berlin). No complete solution to the problem of monitoring stereophonic programmes in the confined space of an O.B. van has been found; attempts made to use headphones for this purpose have proved abortive.

3.2. Programme Distribution

Line transmission of stereophonic programmes by a carrier system has been proposed, but I.R.T. is still considering the possibility of distribution at audio frequency. The 'Ballempfang' system is already used in South Germany for the distribution of monophonic programmes and could be extended to the northern part of the country if the provision of lines for stereophony should prove too difficult.

4. CONTROL OF MODULATION LEVEL

4.1. General

For reasons already set forth in the literature,⁷ I.R.T. is still convinced of the superiority of the peak programme meter to the V.U. meter for control purposes. The speed of operation of the peak reading instrument currently employed has been standardized at an integration time* of 10 ms and a return time of 2 seconds for 20 dB. I.R.T. has great faith in the stability of the German S.B. system and considers it unnecessary to compare meter readings at different points of the chain during the course of the programme. Should such a comparison be made, however, the effect, on the result, of phase distortion or of non-uniform frequency characteristics in the line is thought to be negligible compared with the reading errors involved. In any case, a knowledge of the peak signal voltages actually existing at the various points in the chain is regarded as more important than uniformity in the indicated values.

4.2. Control Instructions

Instructions given to control operators vary according to whether or not the programme is to be subsequently compressed.

In VHF transmitters, limiters are provided only in a few exceptional cases; the programme is controlled so that the PPM indication passes the 100% mark between one and five times per minute, depending on the nature of the programme. In other cases, limiters or compressors are employed and the instructions to the control operator modified to allow some items to exceed the normal maximum level; examples of this practice are given in the next section.

With regard to the relative levels of speech and music, the West German broadcasting authorities are guided by the complaints received from the public and claim now to have reached the state where the proportion of demands for louder speech and louder music respectively are about equal.

*This quantity is defined as the duration of a tone pulse required for the pointer to reach 90% of the corresponding steady-state deflection; it includes the effect of the ballistic constants of the meter.

4.3. Use of Limiters

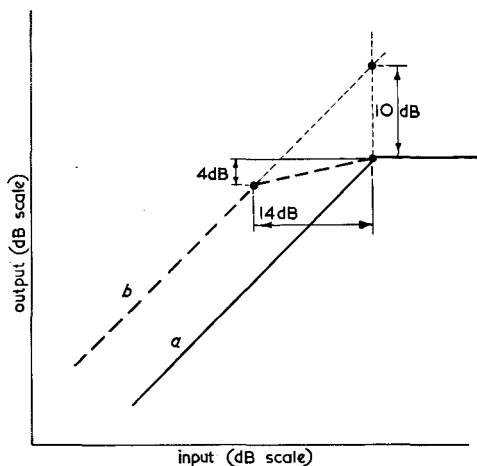


Fig. 2 - Approximate input/output characteristic of U-73 amplifier

- (a) as limiter
- (b) as limiter/compressor

One type of limiter commonly employed, the U-73, is of particular interest as it is designed to give two alternative input-output characteristics. The first, shown diagrammatically in Fig. 2, curve (a), is of the normal limiter type, the output increasing in proportion to the input up to a certain maximum level and remaining constant for higher input levels. The second type of characteristic, shown in Fig. 2, curve (b), combines the features of limiter and compressor; gain reduction begins at an output level about 4 dB below the maximum, and by the time that the limiting output level is reached, the gain is already 10 dB below the no-signal value. The operating time of these limiters is given as 0.3 ms and the release time as 1 to 2 seconds.

The following additional information on the use of limiters and compressors is taken from a survey of current practice in the various organizations of the A.R.D., made by the I.R.T. in February 1962.

Limiters at Transmitters

All television transmitters of W.D.R. are equipped with limiters. Limiters and/or compressors are introduced at many medium wave transmitters, being in some cases permanently in circuit and in other cases switched in during certain parts of the programme on instructions from the studios. The degree of compression is in most cases 10 dB.

Limiters on studio premises

Limiters are also used in some cases at the output of the studio premises to avoid excessive levels being sent over the Post Office lines. In the sound service, limiters or compressors are also introduced in the studio cubicle. In the Nord-Deutscher Rundfunk and Hessischer Rundfunk, this facility is used occasionally for plays and dance music and in the Bayrischer Rundfunk for live announcements between musical items. Compression, amounting to 10 dB, is applied by Westdeutscher Rundfunk to news bulletins in an attempt to match their loudness to that of musical transmissions. Examples of control instructions are: Bayrischer Rundfunk - Speech controlled to 150%* with limiter; symphonic music and plays 100%; 'Pops' 80%, interval music in transmissions for car drivers, 60%. Süddeutscher Rundfunk - Music 85%, speech 120%. Limiters and compressors are also used in television sound, particularly for dance music.

*It should be noted that the German programme meters are scaled in percentage of full modulation as well as in decibels.

4.4. Propaganda Transmissions

Apart from the propaganda transmissions of the Deutsche Welle organization and of stations under American control, all of which use 20 dB of compression, there is no broadcasting transmitter in West Germany in which the quality of the programme received by the home listener is sacrificed for the sake of better reception outside the Federal Republic. However, on special occasions, such as the broadcasting of politically important news or announcements, compression may be temporarily applied and in some cases a bass cut may be introduced to improve intelligibility. Top-lift is never employed, neither is a bass cut ever applied to musical programmes.

4.5. Attempts at Loudness Indication

To meet the special requirements of the television service, consideration has been given during the last few years to the possibility of using a supplementary instrument for indicating the loudness of the programme. Comparative tests with various types of indicating device indicated that a Siemens instrument reading mean values, preceded by a simple weighting network attenuating 9 dB and 3 dB at the lower and upper frequencies respectively, came nearest to satisfying the requirements, but it was also found that an equivalent result could be obtained by increasing the integration time of an existing programme meter to about 50 ms and adding a weighting network as before.

The indications of the supplementary meter can conveniently be displayed on one scale of a double programme meter, of the type employed for stereophonic programmes, the other scale being used for the normal programme meter; an arrangement of this kind has been in experimental service in some television and sound studios for about a year. It is known that the 'loudness' indications are not valid for some of the impulsive noises used in effects, or for the special type of speech delivery which gives the maximum subjective impact for a given sound power; nevertheless, the device has been found adequate for straightforward comparisons between speech and music provided that the dynamic range involved is not very great. The indications of this meter are not intended to act as a substitute for subjective judgment but as a rough guide when the operator is prevented, by some temporary distraction, from giving his attention to the sound from the monitoring loudspeakers, or when the duration of an announcement is too short to allow a proper assessment to be made.

5. MISCELLANEOUS

In the course of discussions on studio equipment, it was noted that magnetic recordings, in the form of closed loops, are being employed for effects. Each recording takes the form of a spirally wound tape enclosed in a cassette, from which it is led out on the inside of the spiral and, after passing the reproducing head, is returned to the outside; this process requires the turns of the spiral to slide one over the other and a special low-friction tape is therefore employed. The playing time of a cassette may be between two and five minutes at 19 cm/sec (7½ in/sec); provision is, however, made for the use of a simple loop of tape containing as little as 1½ seconds of recorded material. The required starting and stopping points on the tape are marked by removing the magnetic coating or by cutting in a length of transparent leader; the transmitted light operates a photocell which in turn controls the drive. The tape replay unit, which is 13.4 cm (5¼ in) × 9.4 cm (3¾ in) × 26.9 cm (10½ in) deep, is manufactured by H. Geiling Elektro-Apparatebau, Munich, at a price of DM 1000. About 100 of these units are at present in use in West Germany.

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